

**SECTION 4.06  
BITUMINOUS CONCRETE**

**4.06.01--Description:** Work under this section shall consist of bituminous concrete placed upon a completed base course upon the surface of an existing pavement or upon the surface of an existing pavement which has been brought to proper grade and cross-section by prescribed means. This work shall be performed in accordance with these specifications and in conformity with the line, grade, compacted thickness and typical cross-section shown on the plans.

**4.06.02--Materials:** The materials for the bituminous concrete mixture, sources of supply, formula for mix, mix tolerances, approval of mix formula and the control of the mixture shall conform to the requirements of Section M.04 attached hereto.

**RECYCLE OPTION**

The Contractor has the option of recycling reclaimed asphalt pavement (RAP). RAP may be recycled in any of the following mixes or applications:

- Class 1
- Class 2
- Class 3
- Class 4

If the Contractor chooses the recycling option, the following modifications to the specification requirements shall apply:

**MATERIALS:** RAP shall consist of asphalt pavement recovered by cold milling or other removal techniques approved by the Director of Research and Materials, or his representative. RAP shall meet the requirements stated in Article M.04.01 -- Reclaimed Asphalt Pavement.

Prior to entry into the mixer, the RAP shall have a reasonably uniform gradation from coarse to fine with a minimum of 93 percent passing the 50 mm sieve.

**COMPOSITION OF MIXTURES:** The blend percentage of RAP shall be a maximum of 40% reclaimed material.

A maximum of 15% RAP may be routinely used after prior notification and approval by the Director of Research and Materials.

RAP shall be last in the aggregate measuring sequence. RAP draw mass(es) shall be increased to compensate for the moisture content as determined by a method approved by the Director of Research and Materials.

The recycled mixture of RAP, new aggregate and added asphalt cement shall meet the requirements specified in Table M.04.03, Bituminous Concrete Mixtures. The added asphalt cement grade shall be selected as described herein.

For any bituminous mixture containing RAP, the Contractor shall formulate and submit to the Director of Research and Materials for approval a Job Mix Formula (JMF) that shall include:

1. Gradation and asphalt content of the RAP.
2. Gradation of recycled mixture.
3. Percentage of RAP to be added.
4. New aggregate source(s).
5. Total asphalt cement content (based on total mixture mass).

6. Added asphalt cement content (JMF) (based on total mixture mass).
7. Production percentage of bitumen (The actual percentage of bitumen shown by mass on the batch plant ticket or drum plant printout.)
8. Grade of added asphalt cement.

**Bituminous Materials:** The added asphalt cement may be a performance graded binder approved by the Director of Research and Materials. The combined asphalt cement (reclaimed bitumen and added asphalt cement) shall meet the requirements of AASHTO MPI.

Bituminous material for tack coat and prime coat shall also conform to Section M.04.

Material for joint sealer for pavement shall be a rubber compound of the hot-poured type and shall conform to Article M.04.02.

### CRUSHED GLASS OPTION

The Contractor has the option of adding clean, environmentally acceptable Crushed, Recycled Container Glass (CRCG) to any of the following mixes:

CLASS 1--Binder only. Not to be used in the surface course.

CLASS 3

CLASS 4

If the Contractor selects the CRCG option, the following modifications to the specification requirements shall apply:

**MATERIALS:** The CRCG shall conform to the gradation shown below and shall contain no more than 1 percent by mass contaminants. Contaminants shall be defined as, but not limited to, paper, metal or plastic.

CRCG GRADING REQUIREMENTS	
PASSING SIEVE SIZE	PERCENT
9.5 mm	100
4.75 mm	35–100
75 μm	0–10

**COMPOSITION OF MIXTURE:** The maximum percentage of CRCG allowed shall be 5 percent of the total aggregate mass. The mixture shall meet all requirements specified in Table M.04.03, Bituminous Concrete Mixtures.

For mixtures containing CRCG, the Contractor shall submit to the Assistant Manager, Division of Materials Testing, for approval, a job-mix formula that shall show the actual percentage of CRCG incorporated into each class of material. The CRCG shall be proportioned from a separate bin, and all requirements for proportioning and recording set forth in Section 4.06.03 shall apply.

An amount of 1 percent hydrated lime, or other approved anti-stripping agent, shall be added to all mixtures containing CRCG.

**4.06.03--Construction Methods:** The methods employed in performing the work and all equipment, tools, machinery and plant used in handling material and executing any part of the work shall be subject to the approval of the Engineer before the work is started; and whenever found unsatisfactory, it shall be changed and

improved as required by the Engineer. All equipment, tools, machinery and plant used must be maintained in a satisfactory working condition. Where called for on the plans the Contractor shall remove the surface of the existing bituminous pavement between the limits and to the depth shown on the plans or as directed by the Engineer, using methods approved by the Engineer, with precaution taken to avoid damage to the existing roadway materials which are to remain in place. The existing bituminous surface that is removed will be reused as a recycled material or disposed of in accordance with these specifications.

**1--Samples:** Samples of the actual mixture will be obtained by Materials Testing personnel as indicated below or at other times as designated by the Engineer.

**(a) Gradation and Bitumen Content:** Generally, five samples will be obtained from each full day's production. Acceptance will be in accordance with Subarticle 4.06.04-3.

When a Laboratory inspector samples material at the job site or at the producing plant and is unable to perform the extraction tests, samples may be obtained to best represent that load or loads of material available at the time.

Mixtures will be sampled and tested for acceptance during the production day. In addition to acceptance samples taken from each day's production, the Engineer may sample any hauling unit containing a mixture which appears to have an obvious deviation from the specifications.

**(b) Cessation of Supply:** A producing plant shall cease supplying materials for the State when material is off the job mix formula on three consecutive samples or the master range for two consecutive samples. The producing plant may also be required to cease supplying material for three non-consecutive samples off the job mix formula or two non-consecutive samples off the master range during any one production day or when the minus 75 mm sieve material exceeds the extracted AC content on three consecutive samples during any production day.

When storage bins are utilized, the following requirements shall apply: A storage bin's usage shall cease and the bin placed "on hold" until acceptable trial test results are obtained from the bin when:

- (1) One (1) production test from a storage bin varies from the master range limits or,
- (2) Two (2) production tests from a storage bin vary from the job mix tolerances.

"Off Test" for purposes of cessation of plant production is any single difference from the value stated in the job mix formula in excess of the Tolerances shown below or beyond the ranges shown in Article M.04.03 Bituminous Concrete Mixtures.

75 $\mu$ m	2%
300 $\mu$ m	4%
600 $\mu$ m	5%
2.36 mm	6%
4.75 mm	7%
9.50 mm and greater	8%
Bitumen	0.4%

After cessation, the plant will be put on trials for that mix. When trials have been approved by the Director of Research and Materials, the plant will return to its normal operation.

**2--Mixing Plant Inspection:** Before any mixture is accepted, the mixing plants shall be inspected and approved by the Director of Research and Materials. In case unsatisfactory mixtures are consistently produced

by a plant previously approved, the Director of Research and Materials, reserves the right to discontinue the use of mixtures from such plant until necessary corrections have been made.

All vendors producing bituminous concrete for the State under the terms of a contract must have their truck-measuring scales, storage scales and mixing plant automated to provide a detailed ticket to accompany each load. Tickets must include the following information:

1. State of Connecticut printed on ticket.
2. Name of producer, identification of plant, and specific storage bin if used.
3. Date and time of day.
4. Type of material\*
5. Net mass of material.
6. Gross mass or tare mass of truck.
7. Project number, purchase order number, name of contractor (if contractor other than producer), whichever applies.
8. Truck number for positive identification of truck.

\*Note: Class 3 mixture to be used for machine-placed curbing must state "curb mix only" on the ticket.

Items 1 through 6 must be printed on the ticket. The time of day may be printed by a separate time clock. Items 7 and 8 may be printed or handwritten legibly.

All trucks used to deliver bituminous materials to State projects shall conform to the legal mass limits of the State of Connecticut. The State reserves the right to check the gross and light mass of any delivery truck. During any check, a two percent ( $\pm$ ) variation in mass from that shown on a producer's printed ticket shall be considered as acceptable evidence that the mass shown on the producer's printed ticket is correct.

If a truck delivers material to a project and the ticket shows the truck is over the legal mass limit, the truck will be allowed to unload. No payment will be made for material which exceeds the allowable gross mass of the truck. In the event that the net mass is less than that shown on the ticket, payment will be reduced to the smaller measured amount.

The State reserves the right to check the tickets. If, through examination of the detailed tickets, it is found that mixture from an overloaded truck was delivered and incorporated into the work, that material in excess of the legal mass limit for that load will be deducted from payment due at the applicable contract price. Payment shall also be reduced if the net masses are found to be less than those shown on the ticket.

The State reserves the right to have an inspector present to monitor batching and /or measuring operations.

If during the production day there is a malfunction of the recording system in the automated plant or truck-measuring scales, the State must be notified immediately. Manually written tickets containing all required information will be allowed for one hour provided there is a physical measuring of each load on currently approved scales. One hour after malfunction of the recording system, trucks will not be approved to leave the plant unless a State inspector is available and present to monitor measuring. Forty-eight hours after the malfunction of the recording system, material will not be approved to leave the plant. No costs will be incurred by the State for any production hours lost due to enforcement of this requirement.

For the verification of masses or proportions, character of materials, and determination of temperatures used in the preparation of the mixture, the Director of Research and Materials or his authorized representatives shall have access at any time to all parts of the mixing plant. A safe and adequate platform or catwalk with stairway and railing shall be provided to accommodate the inspector while checking temperatures and obtaining samples of the mixture once the truck is away from the pugmill discharge area.

(a) Height: Platforms shall be of a height to accommodate safe acquisition of bituminous concrete samples from the type of hauling vehicle being utilized. Producers loading both large (10-wheeler) and small (6-wheeler) vehicles shall be required to have multilevel platforms or separate platforms of different heights from which sampling may be safely accomplished.

(b) Decks shall be designed and constructed in a manner that will produce a safe and rigid surface. Single-level platforms shall be a minimum of 1.0 m wide and 1.9 m long. On multilevel platforms, each level shall have a deck with minimum dimensions of 1.0 m wide by 1.2 m long.

(c) Platform legs and support bracing materials must be strong enough to ensure a rigid structure, free from wobble, and shall be constructed in a manner that will make it impossible to tip the platform when in use. Platforms may either be anchored permanently or be portable.

(d) Sampling platforms shall be located a safe distance from the bituminous concrete plant and a maximum of 25 m from the field laboratory. Platforms shall be so located that in-plant traffic flow is not impaired. At locations with two mixing plants, a single sampling platform may be situated to accommodate both plants, in which event the 25 m maximum requirement may be waived. In such instances, the sampling platform shall be located as close to the laboratory as traffic patterns allow.

**3--Mixing Plant Inspection --Field Laboratory:** At no expense to the State, a field laboratory shall be provided at each plant, equipped for the use of the inspector to perform tests. This laboratory shall be a separate building or room having a minimum floor space of 7.5 m<sup>2</sup> (9.3 m<sup>2</sup> for laboratories constructed after January 1, 1991), with the least dimension to be 1.9 m. The Contractor shall ensure that all State inspectors are given priority in the use of this laboratory. The field laboratory shall be approved by the Assistant Manager, Division of Materials Testing.

The field laboratory shall be equipped with a suitable heating and cooling system able to maintain the temperature between 18°C and 27°C. It shall be clean and free of all materials and equipment not associated with the laboratory. Windows shall be installed to provide sufficient light and ventilation. Light fixtures and outlets shall be installed at convenient locations. A telephone shall be in audible range of the testing area. The laboratory shall be furnished with an adequate workbench that has a suitable width and a minimum total length of 3 m and height of 760-920 mm. A table for sampling that has a minimum dimension of 920 mm by 920 mm shall also be provided.

The field laboratory shall be in compliance with all current OSHA requirements, including the regulation known as the OSHA hazardous communication standard and right-to-know standard.

Plants producing material during nighttime hours shall have suitable lighting at the sample platform and surrounding areas for the inspector to obtain samples safely.

The laboratory shall contain, and be kept supplied with, the following laboratory equipment:

- a. Fire extinguisher, at least one, capable of extinguishing electrical or chemical fires and effective on all solvents used in the laboratory, rated 2A.10BC.
- b. Paint brush, 25-38 mm wide
- c. Hand brush suitable for cleaning sieves
- d. Scoop, 83 mm x 127 mm x 51 mm deep
- e. Pointed shovel with a long handle
- f. Two large spatulas
- g. Heavy Kraft wrapping paper, 920 mm wide, for quartering
- h. Sample splitter suitable for splitting aggregate samples and sand, through and including 37.5 mm aggregate
- i. Five 12 L sample buckets for cold-feed and hot-bin samples
- j. Six metal pie plates with a minimum diameter of 250 mm
- k. Hot plate and infrared lamp of suitable wattage
- l. An oven, thermostatically controlled so as to maintain the required temperature within 3°C. The thermostat shall have a temperature range of 38°C to 93°C. The minimum inside dimensions of the oven shall be 300 mm deep x 430 mm wide x 430 mm high.
- m. A suitable, non-chlorinated solvent approved by the Assistant Manager, Division of Materials Testing, shall be supplied and located at a reasonable distance from the laboratory (not to exceed 25 m). A

materials safety data sheet shall be posted in each field laboratory. Some non-chlorinated solvents may require additional equipment or supplies, which shall be the responsibility of the Contractor and may include a potable water source, a revised disposal method and other items deemed necessary for the particular solvent used.

- n. 1000 ml non-breakable wash bottle or flask
- o. Centrifugal extractor with a 1500 g, minimum, capacity bowl and capable of controlled, variable speeds up to 3600 rpm. A direct disposal is required to carry extracted solvent-bitumen solution directly from extractor bowl to a safe storage point outside of the laboratory.  
FILTER RINGS: A heavy, smooth, white, medium-fast filter paper of a diameter at least equal to the external diameter of the bowl sealing surface and to exceed the internal diameter of the bowl sealing surface by at least 25 mm to conform with AASHTO T 164.  
FILTER PAPER: In addition to the filter rings, filter paper (VWR Scientific, Grade 613 or equal) is required. The filter paper must have a diameter and surface area at least equal to the filter ring.
- p. Suitable forced ventilation sufficient to remove harmful testing solvent vapors from the work area shall be located directly behind and between the extractor and sample drying area and no further than 300 mm above the workbench, with ventilation provisions separate from doors and/or windows. Laboratory air quality shall be monitored and shall conform to the latest threshold limit values.
- q. Eye-wash Station: A double (two-eye) wash station (minimum 2000 ml) shall be located in the field laboratory and readily accessible in an emergency.
- r. Sieve Shaker: One motorized shaker that has both a horizontal sieving motion and a tapping action, or one of equal performance as determined by the Assistant Manager, Division of Materials Testing. Sieve-retaining mechanism must be able to secure at least a 380 mm nest of sieves.
- s. Shaker Timer: An automatic device to stop the electrical shaker after a predetermined time of 0 to 30 minutes.
- t. Thermometer: 10°C to 230°C
- u. Balance: 1500 g capacity, 1 g sensitivity
- v. Mechanical Marshall Hammer conforming to AASHTO T 245: The apparatus shall automatically compact the sample and stop the motor after the desired number of strokes has been applied. The trip mechanism shall be arranged so that the hammer falls the prescribed distance for every stroke. The molds shall be held in position by a spring-loaded clamp ring to allow easy insertion and removal from the compactor. The hammer shall be held in position during compaction by a locking device that makes it simple to insert and remove the hammer.
- w. Marshall Molds conforming to AASHTO T 245. Items required:
  - Two cylinder molds
  - One base plate with sufficient amount of 100 mm paper molding disks
  - One extension collar
  - One specimen extractor (Marshall Mold)The specimen extractor shall be steel and shall have a plunger with a diameter not less than 100 mm and a thickness of 12 mm for extracting the compacted specimen from the specimen mold with the aid of a mold collar. The apparatus shall have a suitable frame to securely hold the mold collar during extraction and shall be equipped with a hydraulic jack able to provide the necessary force to easily extract the compacted Marshall Mold specimen.
- x. Marshall Molding Block conforming to AASHTO T 245
- y. Sieves: Set of U. S. Standard 200 mm sieves, 50 mm high, consisting of one each with pan\* and cover of the following sizes: 75 mm\*, 300 mm\*, 600 mm\*, 2.36 mm, 4.75 mm, 6.3 mm, 9.5 mm, 12.5 mm, 19.0 mm, 25 mm and 37.5 mm (\*may be half-height).

**4--Mixing Plant and Machinery:** The mixing plant used in the preparation of the bituminous concrete shall comply with AASHTO M 156 and 4.06 for a Batch Plant or a Drum Dryer Mixer Plant, except the following requirements shall apply:

The plant shall have a capacity of at least 115 metric tons per hour;

The plant shall have a minimum of four cold-feed storage bins unless otherwise approved by the Director of Research and Materials; cold-feed storage bins shall be constructed and loaded by equipment and methods that prevent intermixing or contamination of the cold-feed aggregates.

Scalping screens or similar devices shall be installed in the cold feed system, to remove any debris or other foreign material in excess of 100 mm. Individual bins shall be labeled for the aggregate sizes being used;

The Plant shall have at hand the required number of standard 22.7 kg test masses for frequent testing of all scales.

In addition to complying with the above requirements, the measuring equipment shall be constructed with the necessary adjustable devices that will permit any part thereof that gets out of alignment or adjustment to be easily readjusted so that the measuring device will function properly. Scales will be checked and sealed by the Weights and Measures Division at least annually and more often if deemed necessary to insure their accuracy.

Hot storage tanks shall be equipped with thermometers and means for positive control of asphalt temperature at all times. Storage tank capacity shall be such as to ensure continuous operation of the plant and uniform temperature of the bituminous material when it is introduced into the aggregate. The lines and valves shall be so arranged that there is no contamination when different bitumens are used for different mixes. Each tank shall be equipped with an accessible valve in the lower half of the bulkhead whereby liquid samples may be taken. Each valve must be maintained in good working order. Provisions shall be made at the drier outlet so that the pyrometer reading may be checked by means of an armored thermometer.

The Director of Research and Materials reserves the right to pass upon the efficiency of the pyrometer; and for better regulation of the aggregate temperature, he may direct the replacement of the instrument by some approved temperature-recording apparatus and may further require that daily temperature charts be filed with him.

For Batch Plants: The mixer shall be a batch mixer of an approved twin pugmill type, suitably jacketed, of not less than 1000 kg capacity, equipped with a sufficient number of paddles or blades and set in proper order to produce properly mixed batches of any material required under these specifications. When the blade clearance exceeds 19 mm, either the shortened blades or the worn liners, or both, shall be replaced to reduce the clearance to 19 mm or less. The mixing blades of the pugmill shall be so set that they shall circulate the mixture in the pugmill in a horizontal direction around the mill, unless otherwise approved by the Director of Research and Materials.

**Automation and Recordation of Bituminous Concrete Plants:** The plant shall be equipped with an automatic mass measuring, cycling and monitoring system approved by the Director of Research and Materials, and installed as part of the batching equipment.

The system shall include equipment for accurately proportioning the various components of the mixture by mass and in the proper order, controlling the cycle sequence and timing the mixing operations. The entire batching and mixing interlock cut-off circuits shall interrupt and stop the automatic batching operations whenever an error exceeding the acceptable tolerance occurs in proportioning.

The automatic proportioning system shall be capable of consistently delivering materials within the full range of batch sizes with the following tolerances:

Each Aggregate Component	± 1.5% of the cumulative mass (each bin)
Mineral Filler	± 0.5% of the total batch
Bituminous Material	± 0.1% of the total batch
Zero Return (Aggregate)	± 0.5% of the total batch
Zero Return (Bituminous Material)	± 0.1% of the total batch

Tolerance controls shall be automatically or manually adjustable to provide proportions within the tolerances above for any batch size.

Recording equipment shall monitor the batching sequence of each component of the mixture and produce a printed record of these operations. For each day's production, each CDOT project(s) shall be provided a clear, legible copy of the recording. There will be provisions so that scales may not be manually manipulated during the printing process. In addition, the system shall be interlocked to allow printing only when the scale has come to a complete rest.

A printed character (asterisk or other) shall automatically be printed on the batch plant printout whenever the automatic batching sequence is interrupted during proportioning of a mixture.

**For Drum Plants:**

(a) Each cold feed bin shall have a device to feed the aggregate accurately and uniformly. No gravity-type feeders will be permitted. The feeding orifice shall be adjustable and indicators provided to show the gate opening. Each feeder shall be interlocked so that production is interrupted within 5 seconds if any cold bin becomes empty or the flow is obstructed.

RAP, if used, shall be fed into the drum so that it will not come in direct contact with the burner flame. Mixing of RAP with this new aggregate shall occur before the bituminous material introduction point.

(b) **Mineral Filler System:** When mineral filler is to be added, it shall be fed from a bin and feeder separate from the aggregate cold bins. The system shall have a device to feed the mineral filler at adjustable rates accurately and uniformly. When mineral filler is proportioned separately, the delivery system shall be accurate to 0.1 percent based on the total mass of the bituminous mixture. The feeder shall be interlocked in such a manner that production is interrupted within 5 seconds if the bin becomes empty or the flow is obstructed. The filler shall be fed in a manner such that no filler is lost in the form of fugitive dust.

(c) **Aggregate Measuring Equipment:** All aggregates including mineral filler shall be measured by a continuous measuring device either as it is proportioned by the individual feeders or after all materials have been deposited on a common belt. Belt scales shall be installed according to the scale manufacturer's recommendations. Means shall be provided for diverting the aggregate after passing over the belt scale and prior to entry into the drum. The belt scale(s) shall have an accuracy requirement of  $\pm 1/2$  of 1%.

Any other measuring device shall be approved by the Director of Research and Materials.

(d) **Bitumen Delivery System:** The bitumen shall be proportioned by a meter and the meter shall be accurate to 0.1 percent based on the total mass of the bituminous mixture. The system shall be interlocked so that production is interrupted within 5 seconds if the bitumen flow to the mixer unit ceases. A temperature compensating device shall be installed in conjunction with the meter to correct the quantity of asphalt to 16° C.

(e) **Proportioning Controls:** All proportioning controls for aggregates, including mineral filler and bitumen, shall be located at the panel which also controls the mixer and temperature. The panel shall have a master control which will increase or decrease the production rate without having to reset the individual controls for each change in production rate.

**1--Aggregate Feed Rate Control:** The plant shall have an adjustable feed rate control for each aggregate bin feeder and mineral filler feeder. The controls shall maintain an aggregate flow accuracy such that the total variation of all materials being drawn per interval of time shall not exceed an amount equal to 1.5 percent of the total mass of bituminous mixture per interval of time. Where the separate addition of mineral filler is required, it shall be added with a maximum variation of 0.5 percent on the basis stated above for aggregates.

The flow rate of aggregate shall be continuously displayed in the control room in metric tons per hour. The maximum resolution shall be 1 metric ton per hour for dry aggregate and 0.1 metric tons per hour for mineral filler if added separately.

**2--Aggregate Mass Indicator(s).** Mass indicators shall display in the control room the masses of dry aggregate and mineral filler in metric tons per hour shall continuously accumulate the masses of material during the production period in the day. Where mineral filler is included in the aggregate passing over the belt scale, only one indicator will be required. The maximum resolution shall be 0.1 metric tons for dry aggregate and 0.01 metric tons for mineral filler if added separately. The indicators shall be re-settable to zero and lockable.

**3--Aggregate Moisture Compensator:** A moisture compensation device shall be capable of electronically changing the wet mass of aggregate to dry aggregate mass. The compensator may be set manually based on moisture tests performed on composite aggregate samples. The maximum graduations on the compensator shall be 0.1 percent. It shall be the daily responsibility of plant personnel to sample and determine the moisture content in the cold-feed aggregates. Additional moisture determinations shall be made as requested by the Director of Research and Materials. A detailed record of the moisture determinations shall be kept and made available to the engineer or his representative upon request.

**4--Bitumen Control:** The bitumen control shall be capable of presetting the actual bitumen content directly as a percentage based on total mass of mixture. The maximum graduation on the bitumen control shall be 0.1 percent.

The asphalt delivery system shall be coupled with the aggregate delivery system to automatically maintain the required proportions as the aggregate flow varies. The delivery tolerance for bitumen shall be  $\pm 0.1$  percent of the total mixture mass. The flow rate of bitumen shall be continuously displayed in the control room and shall have a maximum resolution of 0.1 metric tons per hour.

**5--Bitumen Quantity Indicator:** A bitumen quantity indicator shall display in the control room the quantity of bitumen and shall continuously accumulate the quantity of bitumen during the production period in the day. The maximum resolution shall be 0.01 metric tons. The indicator shall be re-settable to zero and lockable.

**(f) Recordation of Proportions:** The plants shall be equipped with an automatic digital recording device approved by the Director of Research and Materials, that simultaneously records the mass of each aggregate, mineral filler if added separately and bitumen at five-minute intervals during production time and on demand. The recordation shall include the actual bitumen content based upon the bitumen quantity as a percentage of the total mixture mass. The maximum resolution shall be 0.1 metric tons for dry aggregate, 0.01 metric tons for mineral filler if added separately, 0.01 metric tons for bitumen and 0.1% for bitumen content. All recordings shall show the date, including day, month, year, and time to the nearest minute for each print. For each day's production, each CDOT project(s) shall be provided a clear, legible copy of the recording.

Provisions shall be made so that scales used to load the hauling vehicles may not be manually manipulated during the printing process. In addition, the system shall be interlocked to allow printing only when the scale has come to a complete rest.

**(g) Calibration of Feed Rates:** The feed rates of aggregates from the cold bins, mineral filler when used, and bitumen shall be established for each mix type initially by passing the individual aggregates and mineral filler over the continuous measuring device and the bitumen through the meter, respectively. The feed rates shall be checked periodically according to Department written instructions.

**(h) Automatic Aggregate Sampling Device:** An automatic aggregate sampling device shall be provided which will divert a representative combined aggregate sample into a hopper or container for the purpose of gradation testing. The device shall effectively sample the full width and depth of the aggregate flow without losing any portion of the sample. The sampling point shall be after the aggregate is proportioned and prior to its mixing with bitumen.

**(i) Mixer Unit:** The plant shall include a continuous mixer of a type approved by the Director of Research and Materials, having an automatic burner control and capable of producing a uniform mixture within the job mix tolerances. Flights within the drum which are missing, loose, broken, bent, scalloped or worn excessively from their new condition shall be repaired or replaced to the satisfaction of the Director of Research and

Materials. The mixture shall be discharged into a hot bituminous mixture-holding bin meeting the requirements set forth under (j) below.

**(j) Hot Bituminous Mixture-Storage Bins:** Hot bituminous mixtures may be stored in bins especially designed for that purpose at the mixing plant site. Each holding bin shall be inspected and/or tested by the Department to determine acceptance at specific storage times. Acceptance shall be based upon the ability of the holding bin to: (1) hold and discharge mixes within the quality criteria given in 2 (below); and (2) measure and record the quantity of mixture discharged from the bin.

**1--Storage time** is defined as the time interval beginning with the discharge from bituminous concrete mixing unit to the time of completion of discharge from the holding bin. Holding bins will be approved to store mixtures in accordance with Subarticle 4.06.03-5.

**2--Acceptance Criteria for Mix Quality:** After storage, the mixtures shall conform to the requirements of Subarticle 4.06.03-5.

**3--Quantity Documentation:** The quantity of mixture drawn from storage bins and delivered to Department projects shall be measured and recorded on scales meeting the requirements of Subarticle 4.06.03-2. Other quantity measuring and recording devices are permitted subject to the approval of the Director of Research and Materials.

**4--Storage Bin Evaluation and Approval:** Prior to use on Department projects, each storage facility shall be evaluated and approved by the Director of Research and Materials. The scope of the evaluation conducted will be dependent upon the type of mixes proposed for storage and the storage time requested by the Contractor. The evaluation will be based on sampling and testing of stored mixtures unless otherwise directed. If the mixture drawn from a bituminous storage bin shows signs of detrimental aggregate segregation, asphalt migration, asphalt hardening, or improper temperature control, the Director of Research and Materials may discontinue delivery from the storage bins until satisfactory results can be achieved.

**5.** Moisture Samples of the bituminous mixture taken for test from the trucks shall contain no more than one percent (1%) moisture.

**5--Preparation of the Bituminous Concrete Mixtures:** Each batch shall be kept separate throughout the measuring and mixing operations. Excessive heat in the mineral aggregate or bitumen material shall be avoided. As directed by the Director of Research and Materials, tests shall be performed on asphalt cement recovered by AASHTO Method T170 (Modified) and shall meet the requirements of Subarticle M.04.01-5. All producers will add no less than the minimum allowable percentage of bitumen to the mixes, as prescribed in the Master Range Table of Article M.04.03. In mixtures with RAP, the total computed bitumen content (the calculated effective RAP asphalt available and added asphalt cement) must at least equal the minimum allowable percentage of bitumen as prescribed in Table M.04.03. Samples of the bituminous mixture taken for test from the trucks shall contain no more than one percent moisture.

At the discretion of the Director of Research and Materials, samples will be taken to check aggregate coating by AASHTO Method T 195 (modified). The coating of the aggregate shall be equal to that attained by wet mixing to produce a minimum of 95 percent coated particles.

**Storage Bins:** Bituminous concrete mixtures (Class 1, 2, 3, 4 and 12) may be stored in surge bins or storage bins provided that the mixture used from the bins is of a uniform quality and meets all the specification requirements for the particular class involved and, in addition, conforms to the following specific conditions:

**(a)** The storage bins, together with all equipment and methods pertaining to their use, shall be subject to approval by the Director of Research and Materials. Coatings on the bin internal surfaces or additives to the bituminous concrete mixes shall not be used unless specifically permitted by the Director of Research and Materials.

(b) The bins shall be equipped with a light or indicator to show when the level of material reaches the top of the discharge cone. The bins shall not be emptied below the top of the discharge cone until the use of the bin is completed each day. The material remaining in the discharge cone may be rejected if there is evidence of segregation upon discharge into the truck.

(c) The recovered asphalt from the mix samples shall meet requirements of Subarticle M.04.01-5. Samples for these tests will be taken from appropriate points in the conveyor system or trucks loaded from the bins.

(d) Unless so otherwise permitted by the Director of Research and Materials, the bituminous concrete mixtures shall not be stored in holding bins longer than the following periods:

Type Bin	Maximum Holding Time	
	Class 4/	Other Classes
Unheated bin	2 hr	2 hr
Heated; no inert gas in bin	4 hr	8 hr
Heated; inert gas in bin	6 hr	12 hr

Prior approval must be obtained for storage times greater than those indicated above. Mixtures will be evaluated for approval on an individual class basis as determined by the Director of Research and Materials.

For verification of masses or proportions and character of materials and determination of temperatures used in the preparation of the mixture, the CDOT Laboratory personnel shall have access at any time to all parts of the mixing plant.

(e) **Acceptance Criteria for Mix Quality:** After storage, the mixtures shall meet the following criteria:

Test Property	Allowable Variation
a. Temperature	± 10° C from pugmill discharge
b. Gradation	Within job mix formula tolerances
c. Asphalt Content	Within job mix formula tolerances
d. Asphalt Cement Recovered	
from Mixtures by AASHTO Method T170 (Modified):	
1) Viscosity @ 60° C	
If more than 400 Pa·s when tested	
by AASHTO T 202, then	
2) shall apply.	
2) Penetration @ 25° C	50 (min.) by AASHTO T49
3) Ductility @ 25° C	750 mm (min.) by AASHTO T51

**6--Transportation of Mixture:** The mixture shall be transported from the mixing plant in trucks having tight bodies which have previously been cleaned of all foreign material. The use of kerosene, gasoline, fuel oil or similar products for the coating of the inside of truck bodies is strictly prohibited. Truck body coatings may consist of soapy water or commercial oil emulsions (also known as soluble oils) in the proportions recommended by the manufacturer. If such coatings are applied, truck bodies shall be raised immediately prior to loading to remove any excess coating material.

Loaded trucks shall be tightly covered with waterproof canvas or other suitable covers. Mesh-type covers are prohibited. Both front and rear of the cover must be fastened to minimize air infiltration. Hot mixed bituminous concrete shall be delivered at a temperature that is within 15° C of the approved job mix formula.

**7--Paving Equipment:** Paving equipment shall be of the self-powered type with an adapter to provide guidance of the screeding action. The screed or strike-off member shall be adjustable to the shape of the cross-section of the finished pavement. Some method shall be provided for the tilting of the screed while in operation to secure the proper "drag" and to provide the compressive screeded surface required. The machine shall have a sufficient number of

driving wheels so there will be no undue amount of slippage. Whenever the design of the equipment and plan of operation are such that the driving wheels travel on the finished surface of a completed pavement, said wheels shall be equipped with rubber tires or other means to protect the finished surface. Screeding members shall be preheated, and means shall be provided for heating the screeding members by some method that will prevent accumulation of bituminous material. Extendible paver screeds must be of the vibratory type when used.

**Automatic Grade and Slope Control:** All paving equipment shall be equipped with automatic grade and slope screed controls with sensors for either or both sides of the paver which shall be utilized on all paving lifts. These systems shall be capable of overriding the normal function of the self-leveling screed and maintain screed deviation relative to an external reference. The reference may be an existing grade, mat, slab, curb, or string line. However, the string line may not be used as a reference on the finish surface course.

The grade sensor shall react to a reference line or a 10 m long floating beam which moves over the reference.

The transverse slope controller shall be capable of maintaining the screed at the desired slope within  $\pm 0.1$  percent.

**Lighting for Night Paving:** For paving operations which will be performed during hours of darkness, the Contractor shall provide lighting as described below for the purpose of illuminating the work area and equipment. The Contractor shall be responsible for furnishing, mounting, and maintaining in proper working order all of the required lighting. The Engineer will inspect the lighting equipment for conformance to this specification and for proper working order, prior to allowing a nighttime paving operation to commence or continue. A sufficient number of spare lamps shall be available on site as replacements in the event of failures. The Contractor shall equip his paving equipment with lighting fixtures as described below, or with approved lighting fixtures of equivalent light output characteristics.

**PAVER**

<u>Fixture Type</u>	<u>Quantity</u>	<u>Remarks</u>
A-(Fluorescent, twin 1.2 m HO)	3	Mount over screed area
B-(Narrow) or C (Spot)	2	Aim to auger and guideline
B-(Wide) or C (Flood)	2	Aim 8 m behind paver

**ROLLER: Use 4 Type B or 4 Type C Fixtures**

<u>Fixture Type</u>	<u>Quantity</u>	<u>Remarks</u>
B-(250 W. M.H. Wide Beam)	2	Mounted above roller
B-(250 W. M.H. Narrow Beam)	2	Aim floodlights and wide beam
C-(QPAR64 1000 W. Flood)	2	lights 15 m in front of and
C-(QPAR64 1000 W. Spot)	2	behind roller, aim spotlights
		and narrow beam lights 30 m in
		front of and behind roller.

**Fixture Type A:**

Fluorescent fixture shall be heavy-duty industrial type. It shall be enclosed and gasketed to seal out dirt and dampness. It shall be UL listed as suitable for wet locations. The fixture shall contain two 1.2 m long lamps - Type "F48T12CWHO." The integral ballast shall be a high power factor, cold weather ballast, 120 volts for 800 MA HO lamps. Housing shall be aluminum, lens shall be acrylic, lens frame shall be secured to the housing by hinging latches. The fixture shall be horizontal surface mounting, and be made for continuous row installation.

**Fixture Type B:**

The floodlight fixture shall be heavy-duty cast aluminum housing, full swivel and tilt mounting, tempered-glass lens, gasketed door, reflector to provide a wide distribution or narrow distribution as required, mogul lamp socket for 250 watt Metal Halide lamp, 120 volt integral ballast, suitable for wet locations.

**Fixture Type C:**

The power beam holder shall have a ribbed die cast aluminum housing, and a clear tempered-glass lens to enclose the fixture. There shall be an arm fully adjustable for aiming, with a male-threaded mount with serrated teeth and lock nuts. There shall be a 120 volt heat proof socket with extended fixture wiring for an "Extended Mogul End Prong" lamp base. The fixture shall have gasketing, and shall be UL listed as suitable for wet locations. Lamps shall be 1000 watt quartz PAR64, both Q1000PAR64MFL (flood) and Q1000PARNSP (spot) will be required.

**Electric Power:**

The Contractor shall provide generators on rollers and pavers of the type, size, and wattage, to adequately furnish 120 V AC electric power to operate the specified lighting equipment. A sufficient amount of fuel shall be available on site. There shall be switches to control the various lights. Wiring shall be weatherproof and installed to all applicable codes.

**Equipment Mounting:**

The Contractor shall design and fabricate brackets and hardware for mounting light fixtures and generators to suit the configuration of the rollers and pavers. Mountings shall be designed so that light fixtures will be located such that they may be aimed as specified to provide proper lighting. Mounting brackets and fixtures shall not interfere with the equipment operator, or any overhead structures. Mounting brackets and hardware shall provide for secure connection of the fixtures, minimize vibration, and allow for adjustable positioning and aiming of the light fixtures. Lighting shall be aimed to maximize the illumination on each task and minimize glare to passing traffic.

The cost for providing this lighting shall be considered part of the Contractor's equipment and tools, and will not be measured for payment, but will be included in the general cost of work.

**8--Placing of Mixture:** Prior to the placement of the bituminous concrete, the underlying base course shall be brought to the plan grade and cross-section within the allowable tolerance. Immediately before placing the mixture, the area to be surfaced shall be cleaned by brooming or by other means acceptable to the Engineer.

In addition to any other temperature requirements, Class 14 shall be placed when the base and air temperatures in the shade exceed 16° C. Additionally, Class 14 shall not be placed after October 1 or before May 15 unless approved by the Engineer. Attention is directed to Note (a) below.

**(a) Weather and Seasonal Limitations:** The Hot Mix Asphalt (HMA) mixture shall not be placed whenever the surface is damp, wet or frozen. In addition, no pavement will be permitted to be placed on frozen material.

The HMA mixtures shall be placed in accordance with the temperature limitations in Table 1 below.

**TABLE 1  
TEMPERATURE LIMITATIONS FOR PLACEMENT OF HMA PAVEMENT**

Thickness of the Individual course (millimeters)	Minimum Temperatures - Degree C for Air and Surface**	
	<b>Final Course</b>	<b>All Other Courses</b>
Less than 40 mm	10	10
40 to 60 mm	4	4
Over 60 mm	4	0

\*\* Air and surface temperatures are taken in the shade. The surface is defined as the surface on which the new HMA pavement layer is to be placed.

**Seasonal Limitation:** In addition to temperature limitations stated in Table 1, the HMA pavement shall not be placed between October 15 and the following April 15 unless a cold weather paving procedure is submitted and approved by the Engineer. Such approval will not serve to relieve the Contractor of its contractual responsibility for the successful completion of the work.

**(b) Placing and compacting mixture:** Placing the mix in an appropriate ambient temperature and on a surface sufficiently warm to minimize the risk of excessive cooling before completion of rolling is of paramount importance. Holding the aggregate particles in place is solely the function of the film of asphalt. The asphalt cannot perform this function properly if the mix is too cool when rolled.

A thin course compresses very little under the roller and, as it cools quickly, it must be rolled as soon as possible. A high degree of densification is not the goal with this type of mix--the aim is firm seating and contact of the aggregate particles. One or two coverages with a steel-wheeled roller having a mass of 7300 kg to 9100 kg is sufficient. Additional rolling may be excessive, causing a break in the bond of asphalt between aggregate particles, particularly after the mix has cooled.

The Contractor may not alternate the use of trap rock and native stone for fine or coarse aggregates in the top course of any job unless a breaking point is approved by the Engineer.

When overtaken by sudden storms, the Engineer may permit work to continue up to the amount which may be in transit from the plant at the time, provided the mixture is within temperature limits specified.

At the time of placement, the mixture shall be within  $15^{\circ}\text{C} \pm$  of the temperature specified in the approved mix formula unless in the opinion of the Engineer job conditions warrant varying these limits. Upon arrival, the mixture shall be dumped into the approved mechanical spreader and immediately spread and struck off to the full width required and to such appropriate loose depth for each successive course that when the work is completed, the designed depth will be obtained. Each course shall be struck off by the mechanical equipment. For use in striking off the bottom course, the machine shall be equipped with easily adjustable strike-off plates. The hopper and tunnel shall be properly loaded at all times during the paving operation.

In order to obtain tight and well-compacted longitudinal joints, the sequence of the bituminous concrete placing operations for all courses laid shall be subject to the control of the Engineer.

Before any rolling is started, the finished surface struck by the machine shall be checked. Any imperfections shall be repaired and all "dripping" i.e., fat, sandy accumulations from the screed, and all fat spots from any source shall be removed and replaced by satisfactory material.

In areas where, because of physical limitations it is impracticable to operate the paving equipment, the Engineer may permit the use of other type spreaders or the mixture may be spread and screeded by hand.

When hand-spreading is permitted, upon arrival the mixture shall be dumped on approved steel dump sheets outside of the area on which it is to be spread, and shall then be immediately distributed into place by means of suitable shovels and other tools, and spread with metal lutes in a uniformly loose layer of such depth as will result in a completed pavement having the designed depth. Any deviation from standard crown or section shall be immediately remedied by placing additional material or removing surplus as directed. The Engineer may direct that other means of placing the material in addition to the metal lutes be used to ensure a better control of the depths of material and the surface finish.

Contact surfaces of curbs, gutters, manholes, etc., shall be painted with a thin uniform tack coat just before the material is placed against them. Such a tack coat shall not be paid for. As ordered by the Engineer, a very light web-like tack coat shall be applied to the pavement before overlaying. Generally, all surfaces that have been in place longer than five calendar days shall receive a tack coat. Emulsions for tack coat shall be diluted 50/50 with water and shall not be heated in excess of  $70^{\circ}\text{C}$ . Care must be taken not to apply too heavy a coating; application rate of the diluted emulsion shall be 140 to 450 mL per square meter. The emulsion shall be applied by a pressurized spray method and shall include a method of measuring consumption acceptable to the State. The equipment used and method of placing an overall tack coat must be approved by the Engineer in charge of the project.

Refueling of equipment is prohibited in any location on the paving project where fuel might come in contact with bituminous concrete mixtures already placed or to be placed.

Solvents and cleaners for use in cleaning mechanical equipment or hand tools shall be stored well clear of areas paved or to be paved. Before any such equipment and tools are cleaned, they shall be moved off the paved or to-be-paved area; and they shall not be returned for use until after they have been allowed to dry.

Immediately before placing bituminous concrete upon a waterproofing membrane, the waterproofing shall be swept clean by a method which shall not damage the membrane. If damage does occur, it shall be repaired by patching as directed by the Engineer and at no cost to the State.

**9--Compaction:** After placing, each course shall be compacted to meet the following density requirements:

The in-place density of each layer or course of mixture of Class 1 or Class 2 placed shall be compacted to a density of at least 92 percent and no more than 97 percent of the theoretical void-free density.

The in-place density of the completed Class 4 Premixed Bituminous Base shall be not less than 90 percent nor more than 98 percent of the theoretical void-free density.

The in-place density of the longitudinal joint(s) of each course of Class 1 or Class 2 placed at a depth of 40 mm or greater shall be compacted to a density of at least 90 percent and no more than 97 percent of the theoretical void-free density.

Theoretical densities will be determined by AASHTO Method T209 (Modified) (see note 1).

When compacting Class 14, one or two passes are sufficient, using a medium-mass steel-wheel roller (7300 to 9100 kg static load). over-rolling decreases the designed "open-grade" frictional value.

Cessation temperature for continued compaction of the mat shall be 80° C.

All paving and compaction equipment, whether vibratory or non-vibratory, must be of a type and size approved by the Engineer. Such equipment must be maintained in proper operating condition and must be ready, at the job site, prior to delivery of bituminous concrete.

On certain bridge deck overlays and paving jobs where, due to physical limitations, a full roller contingent is not practical, the Engineer may at his option utilize a lesser number of rollers provided all compaction requirements are met.

**Non-Vibratory Rollers:** In general, rolling shall consist of initial or breakdown rolling, intermediate rolling and final or finish rolling. Rolling shall be performed with at least two power-driven steel-wheel tandem or 3-wheel rollers having a mass of not less than 9100 kg for each single lane paver. Intermediate rolling may be done with a self-propelled pneumatic tire roller. If a pneumatic tire roller is used, it shall be equipped with wide-tread compaction tires capable of exerting an average contact pressure from 420 to 620 kPa uniformly over the surface, adjusting ballast and tire inflation pressure as required. The Contractor shall furnish evidence regarding tire size, pressure and loading to confirm that the proper contact pressure is being developed and that the loading and contact pressure are uniform for all wheels.

All non-vibratory rollers shall travel at a speed no greater than 8 km/h (2.2 m/s).

**Vibratory Rollers:** The Contractor may include a vibratory roller in the compaction train providing the vibratory roller is operated in accordance with the manufacturer's recommendations. The vibratory roller shall be of a self-propelled type specifically designed for the compaction of bituminous concrete.

Vibratory rollers shall be equipped with a speed control device which shall be set by the Contractor to prevent the roller from traveling in excess of 4 km/h (1.1 m/s) when the roller is operating in a vibratory mode, and 8 km/h (2.2 m/s) when the roller is operating in the static mode.

All vibratory rollers shall be shut off from the vibrating mode when reversing directions. All vibratory rollers shall be equipped with automatic reversing eccentrics (masses).

The Contractor may substitute one vibratory roller for both a breakdown roller and pneumatic roller for the compacting train. The course shall be finish-rolled with a steel-wheel tandem roller having a minimum mass of 9100 kg.

Dual vibrating drum roller meeting the requirements of a steel-wheel tandem roller and operating in the static mode may be used as the finish roller; however, this single vibratory roller shall not be used as both the breakdown roller and the finish roller.

One vibratory roller and one steel-wheel tandem roller shall be provided for each single-lane paver. The type(s) of rollers and number must be approved by the Engineer.

The use of a vibratory roller in the dynamic or vibratory mode is strictly prohibited on bridge decks or concrete structures.

The Contractor assumes full responsibility for the cost of repairing all damages which may occur to highway components and adjacent property. If the Engineer determines that the compaction obtained is less than that specified, or damage to highway components and/or adjacent property occurs with the use of the vibratory compaction equipment, the Contractor at no additional expense shall immediately cease using the equipment and shall proceed with the work in accordance with the conventional compaction procedure outlined in the specifications.

**10--Surface Test of the Pavement:** For the purpose of testing the finished surface, random spot-checks will be performed with a contractor-supplied, standard 3 m straightedge. The Contractor shall provide or designate some employee whose duty it is to use the straightedge under the observation of State personnel.

The finished pavement shall be such that it will not vary more than 6.4 mm from a 3 m straightedge applied parallel to the centerline of the pavement. This tolerance shall apply to all paved areas including pavement abutting bridge decks and concrete bridge deck headers. Any irregularity of the surface exceeding the above limits shall be corrected. Depressions which may develop after the initial rolling shall be remedied. Such portions of the completed pavement as are defective in surface, compression or composition, or that do not comply with the requirements of the specifications shall be taken up, removed and replaced with suitable mixture, properly laid in accordance with these specifications at the expense of the Contractor.

The surface of the finished base course shall not vary by more than 9.5 mm from a 3 m straightedge applied parallel to the centerline of the base.

**11--Joints:** Placement of the bituminous material shall be as continuous as possible. Rollers shall not pass over the unprotected end of a freshly-placed mixture unless authorized by the Engineer. Transverse joints shall be formed by cutting back on the previous run, existing bituminous concrete pavement, or bituminous concrete driveways to expose the full depth of the course. Waste materials shall be removed from the project site by the contractor at no cost to the State. All waste materials shall be disposed of in an acceptable manner. On any cold joint, a brush coat of asphaltic material or approved equal shall be used on contact surfaces of transverse and longitudinal joints just before additional mixture is placed against the previously rolled material.

The longitudinal joint in one layer shall offset the previous joint in the layer immediately below by approximately 150 mm however, the joint in the top layer shall be at the centerline of the pavement if the roadway comprises two-lane width, or at lane lines if the roadway is more than two lanes in width. In compacting the joint, the steel-wheel roller shall be shifted onto the previously placed lane so that only 25 to 50 mm of the drive wheel extends over the uncompacted material. The steel-wheel roller shall continue to roll along this line and its position shifted gradually across the joint until the joint has been rolled with the entire width of the drive wheel. Rolling with steel-wheel and pneumatic-tired rollers shall be continued until a thoroughly compacted, neat joint is obtained. When the vibratory roller is used for breakdown rolling, compacting the joint shall be accomplished with the roller on the uncompacted material shifted 25 to 50 mm across the joint onto the previously placed lane.

**(a) Sawing and Sealing Joints in Bituminous Concrete Pavement:** Work under this item shall consist of making a saw cut across the finished surface of bituminous concrete pavement directly over existing joints in the

underlying pavement or bridge deck and immediately sealing with an approved joint-seal material so as to prevent the traffic from damaging the sawed joint.

Joints to be cut will be determined by the Engineer and referenced by the Contractor prior to the paving operation. The saw cut portion of the joint shall be made with an approved power-driven saw. The joint shall be cut to a depth of 13 mm, 10 mm wide. The cut will be in a straight line across the pavement directly over the existing joint. Transverse joints shall extend to a point 0.6 m beyond the underlying concrete pavement. The sawed joints shall be cleaned with compressed air of sufficient pressure to ensure a thorough cleaning. Immediately following the cleaning, the joint seal material shall be applied through a nozzle which must project into the saw cut or constructed joint, filling from the bottom up. The hot-seal material shall completely fill the joint or saw cut such that after cooling, the level of the sealer will not be greater than 3.2 mm below the pavement surface. Any depression in the seal greater than 3.2 mm shall be brought up to the specified limit by further addition of hot-seal material. Care shall be taken during the sealing operation to ensure that the final appearance will present a neat line.

**(b) Cleaning and Sealing Joints and Cracks in Highway Pavement:**

Work under this item shall consist of cleaning existing joints and cracks of all dirt, dust, loose joint material, and all deleterious matter with compressed air of sufficient pressure to ensure thorough cleaning. After a sufficient number of joints and cracks have been cleaned so as to ensure a continuous operation, all joints and cracks shall be sealed with an approved joint-seal material, hot-poured elastic type conforming to M.04.02.

This operation will start with the cleaning of all existing joints and cracks with compressed air of sufficient pressure to ensure a thorough cleaning. These joints and random cracks shall then be filled with paper rope wherever possible to a level of 25 mm below the riding surface of the road. Joint-seal material shall then be applied through a nozzle which must project into the constructed joint or random crack, filling from the bottom up. The hot-seal material shall completely fill the joint or crack such that after cooling, the level of the sealer will not be greater than 3.2 mm below the pavement surface. Any depression in the seal greater than 3.2 mm shall be brought up to the specified limit by further addition of hot-seal material. Care shall be taken during the sealing operation to ensure that the final appearance will present a neat line.

**(c) Cutting and Sealing Joint in the Bituminous Concrete Shoulder:** Work under this item shall consist of making a longitudinal cut at the bituminous concrete shoulder-portland cement concrete pavement interface and sealing this cut with hot rubber asphalt joint seal conforming to M.04.02. The joint shall be cut entirely in the bituminous concrete shoulder and be contiguous with the abutting portland cement concrete pavement. The size of the cut shall be 13 mm wide by 38 mm deep. The cut shall be made at such time that the shoulder material is in condition to produce a clean cut and is able to withstand the eroding effects of the saw or other cutting device. The joint shall be thoroughly clean and dry prior to placement of the sealing compound. Any cleaning required shall be performed by pneumatic methods to remove all deleterious matter that may have accumulated in the joint. Sufficient air pressure shall be provided to ensure a thorough cleaning. Immediately following the cleaning, the joint seal shall be applied through a nozzle which must project into the joint, filling the joint from the bottom up. The hot seal shall completely fill the joint such that after cooling the level of the sealer will not be greater than 3.2 mm below the pavement or shoulder surface. Any depression in the seal greater than 3.2 mm shall be brought up to the specified limit by the further addition of hot seal. Care shall be taken in the sealing of the joint so that the final appearance will present a neat, fine line. Overfilling of the joint will not be allowed and spillage of the sealer shall be avoided.

**(d) EQUIPMENT:**

**Kettle:** This unit is to be a combination melter and pressure applicator. It shall be a doubleboiler type with space between the inner and outer shells filled with oil or other material for heat transfer. The material for transferring heat shall have a flash point of not less than 320° C. Positive temperature control and mechanical agitation shall be provided. Direct heating shall not be used. The temperature of the sealing compound shall be maintained within the range specified by the manufacturer. A thermometer shall be suitably mounted to indicate the temperature of the compound in the melter.

**Compressor:** The compressor shall have a minimum rated capacity of 620 kPa and shall have sufficient hose to maintain a continuing sealing operation without interruption.

**Joint Saw:** The saw shall be an approved power-driven type capable of providing a straight cut of uniform depth and width.

**Control of Joint Seal Material:** The temperature at which this material is to be applied shall be within the range specified by the manufacturer. The actual temperature of the joint seal material in the melter shall not exceed by more than 8° C the manufacturer's specified temperature. Any material that does exceed this limit will not be accepted.

The joint seal material shall be poured as soon as possible after the recommended pouring temperature has been reached. Only as much material as can be poured in a given day shall be melted that day. In the event of circumstances beyond the control of the Contractor which prevents him from pouring sealing material already melted, he shall reduce the temperature of the material to between 135 and 165° C, and maintain that temperature until just prior to the time sealing operations are resumed. Melted material shall not remain in the melter or applicator(s) overnight. At the close of each day's operations, all material remaining in the melter and applicators shall be drawn off and stored in containers approved by the Engineer. Material so salvaged may be fed back into the melter in a proportion of 25 percent salvaged material to 75 percent new material.

**12--Protection of the Work:** Sections of the newly finished bituminous work shall be protected from traffic to avoid damage to the newly placed material.

**4.06.04--Method of Measurement:** The quantity of bituminous concrete to be included for payment will be determined by the net mass, in metric tons, measured in the hauling vehicles on scales or by automatic recording equipment furnished by and at the expense of the Contractor. The scales or automatic recording equipment shall be of a type satisfactory to the Engineer and shall be sealed.

The total mass will be the summation of the mass slips of bituminous concrete actually incorporated in the work included under this item. The quantity to be included for payment for this work shall be subject to the following:

**1--Determination of Thickness:** The thickness of each course will be determined by depth measurements taken immediately after completion of the breakdown rolling and while the mixture retains sufficient heat to allow corrective measures to be taken except as noted below. The depth measurements will be considered as applying for the full width of the lane. The locations and intervals of the measurements will be as determined by the Engineer, and all information relative thereto will be recorded in the project records.

In the event the depth measurements show variation in thickness beyond the limits specified in 2. -- Adjustments of Measured Mass--additional depth measurements will be taken to determine the longitudinal limits of such variation.

For resurfacing or leveling projects, the thickness of each course will be determined by checking the theoretical yield of the amount of material placed over a given area supplemented by depth measurements. Depth measurements on resurfacing or leveling projects will be taken immediately after paver lay-down and just prior to breakdown rolling. The information relating to checking the theoretical yield factor and any depth measurements taken within the same area will be recorded in the project records. Intermediate depth measurements will not be required to be entered in the project records.

**2--Adjustment of Measured Mass: Class 4**

(a) No adjustment of the mass as determined from the mass slips will be made where the thickness of the premixed bituminous concrete base does not exceed a tolerance of plus or minus 19 mm from the depth shown on the plans.

(b) Where the thickness of the premixed bituminous concrete base exceeds that shown on the plans by more than 19 mm, an amount equal to the computed mass of that material in excess of the tolerance limit will be deducted from the mass determined from the weigh slips.

(c) Where the thickness of the premixed bituminous concrete base is less than that shown on the plans by more than 19 mm, the Contractor, with permission of the Engineer, shall place a correction course not less than 25 mm in depth after compaction, provided an acceptable grade and cross-section can be achieved. Where an acceptable grade and

cross-section cannot be achieved through the above means, the Contractor shall reconstruct, by cutting back and into the pavement having no more than 19 mm deficiency in thickness, a sufficient distance to permit the placement of an acceptable depth, and place new material to achieve the proper depth, cross-section and profile.

**Classes 1, 2, and 12:**

(d) No adjustment of the mass, as determined from the mass slips, will be made where the thickness does not exceed a tolerance of plus or minus 13 mm of the depth shown on the plans.

(e) Where the thickness exceeds that shown on the plans by more than 13 mm, an amount equal to the computed mass of that material in excess of the tolerance limit will be deducted from the mass determined from the mass slips.

(f) Where the thickness is less than that shown on the plans by more than 13 mm, the Contractor, with permission of the Engineer, shall place a correction course no less than 25 mm in depth after compaction, 38 mm for a wearing surface of Class 1, provided an acceptable grade and cross-section can be achieved. Where an acceptable grade and cross-section cannot be achieved through the above means, the Contractor shall reconstruct by cutting back and into the pavement a sufficient distance to permit the placement of an acceptable depth, and place new material to achieve the proper depth, cross-section and profile. These areas where a corrective course is placed or reconstruction of the pavement is performed, will be measured again as though originally constructed; no compensation will be made to the Contractor for the material removed or removal of materials and disposal thereof, or for restoration of affected supporting base or adjacent construction.

(g) An adjustment in quantity will be made in each course of bituminous concrete placed beyond the horizontal limits indicated on the plans by deducting the computed mass of the material extending horizontally by more than the plan depth of each course of bituminous concrete.

(h) Bituminous concrete used in leveling courses or one-course applications without leveling course will not be subject to the adjustments as specified in paragraphs (a), (b), (c), (d), (e), (f) or (g) immediately above, but will be measured for payment by the actual mass incorporated in the accepted work.

**Class 14:**

(i) No adjustment of the mass, as determined from the mass slips, will be made where the thickness does not exceed a tolerance of plus or minus 6.4 mm of the depth as shown on the plans.

(j) Where the thickness is less than the minus 6.4 mm tolerance, the Contractor shall remove and replace with the correct lift thickness for that area affected.

(k) Where the thickness exceeds that shown on the plans by more than 6.4 mm, an amount equal to the computed mass of material in excess of the tolerance limit will be deducted from the mass determined from the mass slips.

**Classes 1, 2, 4, 12 and 14:**

(1) The computed mass, solely for the purposes of determining deductions from the total mass indicated by the mass slips will be computed on this basis of 62.4 kg per square meter per 25.4 mm of thickness for Classes 1, 2, 4 and 12. Class 14 shall be computed on the basis of 51.5 kg per square meter per 25.4 mm thickness.

**3--Adjustment for Material Deficiency:**

For the following classes, the listed sieve sizes and bitumen content will be considered for the purposes of adjusted payment.

<b>Classes</b>	<b>Sieve Sizes</b>
1	75 µm, 300 µm, 600 µm, 2.36 mm, 4.75 mm, 9.5 mm, and 12.5 mm

2	75 µm, 300 µm, 600 µm, 2.36 mm, 4.75 mm
4	75 µm, 300 µm, 2.36 mm, 4.75 mm, 9.5 mm, and 19.0 mm
14	75 µm, 2.36 mm, 4.75 mm, 9.5 mm

**MAXIMUM ALLOWABLE DEVIATION  
FROM THE JOB MIX FORMULA FOR  
CONSECUTIVE TESTS**

**Adjustment Payment Schedule**

	<b>M.A.D.</b>	<b>% Payment</b>
Bitumen	0.4	90
75 µm	2.	90
300 µm	4.	90
600 µm	5.	90
2.36 mm	6.	90
4.75 mm	7.	90
9.5 mm, 12.5 mm, 19.0 mm	8.	90

A minimum of 275 metric tons per day is a requisite for applying an adjusted unit price under these applications.

When the material is not within the maximum allowable deviation from the Job Mix Formula for three consecutive tests, or is not within the maximum allowable deviation of the Master Range Limits for two consecutive tests, the material may be allowed to remain in place. The Department will adjust payment for such material allowed to remain in place as listed in the Maximum Allowable Deviation Table above.

Normally, five tests will be obtained with a minimum of two as a requisite for adjustment purposes under these specifications.

In the event that a selected sample fails, another sample will be taken. The producer will be notified of the test results such that appropriate changes can be made. Additional samples will be taken to indicate production is either back on test or to determine the amount of material that is subject to an adjustment in payment in accordance with the table.

The adjustment in payment shall apply to the production from the time the first test was off until the time the material was back on test. If, however, the first two consecutive tests of the day are not within the allowable tolerances of the Master Range or if the first three consecutive tests of the day are not within the allowable tolerances of the Job Mix Formula, the adjustment in payment shall apply to all material produced until the time when the material is back on test. When multiple plants are located at one site, material supplied to one project is considered as coming from one source for the purpose of applying adjusted payment.

The pay factor will be applied to the net price per metric ton as shown in the Annual Bid Contract Award entitled "1304 Bituminous Concrete Materials." The price per metric ton shall be that price quoted at the plant for the specific class of bituminous concrete furnished.

The bid contract in affect at the time the material is furnished shall govern the price per metric ton to which the pay factor shall be applied. If no bid contract is in existence at the time the bituminous concrete is delivered, the latest bid contract price will be used. In the event a supplier has not bid on the above contract award, the price per metric ton

for the purposes of applying the adjustment payment will be computed by averaging the bid price of three suppliers in the closest proximity to the non-bidding supplier's plant.

#### **4--Adjustment for Density:**

This density requirement shall be applied to all construction and resurfacing projects in which the compacted depth of the pavement is 38 mm or more and requiring a minimum of 275 metric tons/day. The in-place density of each course of the Class 1 and 2 shall be compacted to a density of at least 92 percent and no more than 97 percent of the theoretical density as determined by the Director of Research and Materials. Class 4 shall be compacted to a density of at least 90 percent and no more than 98 percent of the theoretical density. The in-place density of the longitudinal joint(s) of each course of Class 1 or Class 2 placed at a depth of 40 mm or greater shall be compacted to a density of at least 90 percent and no more than 97 percent of the theoretical void-free density.

The completed pavement, mat and longitudinal joint(s) will be tested with respect to compaction on a lot-to-lot basis. A "lot" shall be defined as that amount of pavement placed in meters, measured longitudinally at the time of testing. A lot shall consist of ten equal sub-lots.

When multiple lane paving is required, the 10 sublots shall be divided equally among the total linear feet of longitudinal joints. The average densities from the ten sublots shall be used to determine payment according to the payment schedule entitled "Schedule of Payment - Joint Density."

When one test per sub-lot is below the acceptable density the Engineer shall take the necessary steps to correct the deficiency. Additional rolling may be performed until the pavement temperature drops to 80° C.

If the lot represents a day's run, the average percent density of the ten sub-lots shall be used to determine payment in accordance with the payment schedule.

When a lot consisting of ten sub-lots does not meet density specifications and does not represent the day's production, a second lot shall be required. When a second lot is required, it shall not incorporate any part of the first lot. Prior to beginning the second lot, the time of rejection for the first lot shall be noted for penalty purposes. The payment shall be computed and applied in the following manner:

The average density for each lot shall be determined by averaging the sub-lots within each lot. The penalty assigned each lot shall be in accordance with the following:

SCHEDULE OF PAYMENT - MAT DENSITY

Average Percent Density of Ten (10) Sub-lots	Percent Payment In-place Price
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CLASSES 1 AND 2

-	100	98		97.5
	97	92		100
	91	90		97.5
	89	88		96
	87	or less		92 or rejection

CLASS 4

100	99		97.5
98	90		100
89	88		97.5
87	86		96
85	or less		92 or rejection

The average longitudinal joint density for each lot shall be determined by averaging the densities of the ten sublots. The adjustment assigned each lot shall be in accordance with the following:

SCHEDULE OF PAYMENT - JOINT DENSITY

Average Percent Density Class 1 and 2	Percent Payment (In-Place Price)
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100 - 98	97.5
97 - 90	100.0
89 - 87	97.5
86 - 84	90.0
83 or less	70.0

Note -- If neither the average in-place mat or joint density of the pavement meets the applicable specification requirement (i.e.: an average in-place density of [a] 92 - 97% of the theoretical mat density, and [b] 90 - 97% of the theoretical joint density, for Classes 1 and 2), then the percent of the unit price that the Department will pay to the Contractor will be the lower of either (1) the percent of the unit price that would be paid if payment were based only on the average mat density or (2) the percent that would be paid if based only on the average joint density.

As requested by the Engineer, four or more additional tests may be taken in the last 45 to 60 m of the newly placed pavement. If more than 25 percent of the additional tests fail, the lane will remain closed to traffic until the material is compacted to meet the 75 percent or more acceptance rate for the additional tests. These additional tests will not be included in the average density for payment purposes. The percent of payment shall be applied to the price per metric ton as bid.

**5--Cut Bituminous Concrete:** The cutting of bituminous concrete pavement will be measured for payment by the number of meters of cut made by an approved method to the lines delineated on the plans or by the Engineer. Cuts made necessary by the Contractor's operation such as but not limited to patching, bituminous concrete samples, continuance of previous runs, faulty work or faulty materials will not be measured for payment. Bituminous driveways and parking areas are considered as bituminous concrete pavement.

**6--Referencing, Sawing, and Sealing Joints** will be measured for payment by measuring in place the actual number of meters of joints sawed and sealed in the bituminous concrete pavement surface as agreed and accepted by both the Contractor and the Engineer. Daily records shall be kept by both the Contractor and the Engineer with the daily accomplishment, in meters, agreed upon at the close of each workday.

Cleaning and Sealing Joints and Cracks will be measured for payment by the actual number of kilograms of joint-seal material in place as agreed and accepted by the Contractor and the Engineer. Daily records shall be kept by both the Contractor and the Engineer with the daily accomplishment, in kilograms, agreed upon at the close of each workday.

Cutting and Sealing Joint in the Bituminous Concrete Shoulder will be measured for payment by the actual number of meters of joint, cut and sealed, in the bituminous concrete shoulder, measured in place and accepted.

Material for Tack Coat will be measured for payment as follows: The laboratory will establish a mass per liter of the bituminous material, based on the specific gravity at 16° C, for the material furnished. The number of liters furnished will be determined by measuring the material on scales furnished by and at the expense of the Contractor. Removal of the existing bituminous surface will be measured for payment by the number of square meters of bituminous area removed.

**4.06.05--Basis of Payment:** The furnishing and placing of bituminous concrete will be paid for at the contract unit price per metric ton for "Bituminous Concrete, Class ( )."

The cutting of bituminous concrete pavement will be paid for at the contract unit price per meter for "Cut Bituminous Concrete Pavement."

The referencing, sawing, and sealing joints will be paid for at the contract unit price per meter for "Sawing and Sealing Joints."

The cleaning and sealing of joints and cracks will be paid for at the contract unit price per kilogram for "Cleaning and Sealing Joints and Cracks."

Material for tack coat will be paid for at the contract unit price per liter for "Material for Tack Coat."

The cutting and sealing joint in the bituminous concrete will be paid for at the contract unit price per meter for "Cutting and Sealing Joint in the Bituminous Concrete Shoulder."

Payment for removing existing bituminous surface will be made at the Contract unit price per square meter for "Removal of Bituminous Surface," which price shall also include its reuse as a recycled material or disposal in accordance with these specifications. Payment for the above will be for the items completed and accepted in place, the price of which shall include materials, equipment, labor, and work incidental thereto.

Pay Item	Pay Unit
Bituminous Concrete, Class ( )	t
Cut Bituminous Concrete Pavement	m
Sawing and Sealing Joints	m
Cleaning and Sealing Joints and Cracks	kg
Material for Tack Coat	L
Cutting and Sealing Joint in the Bituminous Concrete Shoulder	m
Removal of Bituminous Surface	m <sup>2</sup>